CLAIMS

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1. A loudspeaker comprising a resonant panel-form member adapted to produce an acoustic output and a vibration exciting system on the panel-form member and adapted to apply bending wave energy thereto, ~~characterised in that~~ wherein the vibration exciting system is adapted to apply a bending couple to the panel-form member.

2. A loudspeaker according to claim 1, wherein the vibration exciting system is adapted to apply torsion to the panel-form member.

3. A loudspeaker according to claim 1 ~~or claim 2~~, wherein the vibration exciting system is adapted to apply shear to the panel-form member.

4. A loudspeaker according to any one of claims 1 to 3, characterised in that the vibration exciter is coupled to the panel-form member to span a plurality of nodal lines in the panel-form member.

5. A loudspeaker according to ~~any preceding~~ claim, wherein the vibration exciting system comprises a suspension on which the panel-form member is mounted, the suspension acting as a pivot about which at least a portion of an edge of the panel-form member local to the vibration exciting system can hinge.

6. A loudspeaker according to claim 5, wherein the suspension is of a plastics foam of high shear stiffness.

7. A loudspeaker according to ~~any preceding~~ claim, wherein the vibration exciting system comprises a piezoelectric device attached to the panel-form member to

apply a bending couple thereto by introducing alternating tension and compression to the panel-form member in the plane thereof.

8. A loudspeaker according to claim 7, wherein the piezoelectric device is attached to a face of the panel-form member.

9. A loudspeaker according to ~~claim 7 or~~ claim 8, comprising mirror-image piezoelectric devices attached to opposite faces of the panel-form member.

10. A loudspeaker according to ~~any one of~~ claims 7 ~~to 9, when dependent on claim 5 or claim 6~~, wherein the piezoelectric device has a portion disposed adjacent to the suspension, and a portion disposed remotely from the suspension.

11. A loudspeaker according to ~~any one of~~ claims 7 ~~to 11~~, wherein the piezoelectric device is a thin strip-like device fixed to the panel-form member by adhesive.

12. A loudspeaker according to ~~any one of~~ claims 7 ~~to 11~~, wherein the piezoelectric device is a unimorph device.

13. A loudspeaker according to claim 12, wherein the unimorph device comprises opposed parts arranged such that one part increases in length while the other part contracts.

14. A loudspeaker according to any preceding claim, wherein the panel-form member is transparent.

15. A loudspeaker according to ~~any one of~~ claims 7 ~~to~~ 14, wherein the piezoelectric device is transparent.

16. A loudspeaker according to ~~any one of~~ claims 7 ~~to 15~~,

wherein the piezoelectric device is of PZT.

17. A loudspeaker according to ~~any one of claims 1 to 6 or 14~~ claim 1 or claim 5, wherein the vibration exciting system comprises an inertial device.

18. A loudspeaker according to claim 17, wherein the inertial device comprises an inertial mass rigidly fixed to the panel-form member to form a suspension pivot.

19. A loudspeaker according to claim 17, wherein the inertial device is an inertial vibration exciter.

20. A loudspeaker according to claim 19, comprising opposed inertial vibration exciters on opposite sides of the panel-form member.

21. A loudspeaker according to claim 19 ~~or claim 20~~, comprising an additional inertial vibration exciter on the panel-form member and coupled to the first said inertial vibration exciter in anti-phase to damp unwanted whole body movement of the panel-form member.

22. A loudspeaker according to ~~any one of claims 1 to 6 or 14~~ claim 1 or claim 5, wherein the vibration exciting system comprises an electrodynamic motor having a rotor with a current-carrying conductor array fixed to the panel-form member with its axis parallel to the plane of the member to apply torsion thereto, and a magnet forming a magnetic field in which the rotor is positioned.

23. A loudspeaker according to ~~any one of claims 1 to 6,14,17 or 19~~ claim 1 or claim 5, wherein the vibration exciting system comprises a bimorph piezoelectric device which is generally rectangular and orientated diagonally to act as

a twister.

24. A loudspeaker according to any one of claims 1 to 6, 14,22 or 23, wherein the vibration exciting system comprises an element rigidly coupled to and projecting away from the panel-form member, and means to induce bending moments in the element.

25. A loudspeaker according to claim 24, wherein the element is generally perpendicular to the panel-form member, bending moments are produced by displacement in a part of the element spaced from the panel-form member, and the displacement is generally perpendicular to the element.

26. A loudspeaker according to claim 25, wherein the displacement is effected using a piezoelectric device.

27. A loudspeaker according to ~~claim 24 or~~ claim 25, wherein the displacement is effected by an inertial device.

~~28~~. A method of making a loudspeaker having a resonant panel-form member adapted to be excited to produce an acoustic output by the application of bending wave energy, comprising defining the panel-form member, mapping the panel-form member to determine the location of nodal lines, arranging a vibration exciting system on the panel-form member to apply bending wave energy thereto, with the exciting system spanning a plurality of the nodal lines and mounting the vibration system exciting to the panel-form member to apply a couple thereto.

29. A method according to claim 28, wherein the panel-

form member is defined in terms of geometry, size and/or mechanical impedance.

30. A method according to claim 28 or claim 29, wherein the panel-form member is mapped using finite element analysis.

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31. A method according to ~~any one of~~ claim~~s~~ 28 ~~to 30~~, comprising mounting the panel-form member on a suspension such that the suspension acts as a pivot about which an adjacent portion of the panel-form member can hinge, and arranging and mounting a vibration exciter on the adjacent portion of the panel-form member to bend the panel-form member.

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~~32.~~ A vibration exciter for applying bending wave energy to a stiff resonant loudspeaker panel-form member and adapted to apply a bending couple to the member.

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